EMWD Mills Pump Station
NoxTech Project Status Update

EASTERN MUNICIPAL WATER DISTRICT
SINCE 1950

NOXTECH

Project Status

• Installation Began	May 2010
• Variance – 500HP Engine not BACT	July 2010
• NoxTech Start-Up Testing Began	September 2010
• Variance – Additional Testing Hours	December 2010
• Variance Expired – Start-up On Hold	March 2011
• Variance – Additional Testing Hours	In Progress

Technical Challenges

- Equipment Set-Up and Integration
- Combustion Kinetics in the Reactor:
  - Temperature
  - Gas composition
  - Residence time & reactions
  - Flow velocity & mixing
- Insufficient Reactive Free Radicals Formation:
  - Premature combustion/oxidation of add fuel (natural gas)
  - Low percent NOx removal

NoxTech Selection

- Successful at Woodville, California – Exceeded Rule 1110.2 Emissions Requirements for:
    - NOx (11 ppmvd)
    - CO (30 ppmvd)
    - VOC (250 ppmvd)
- AQMD Interest and Financial Support
- No Other Proven Technologies for Biogas Applications
- EMWD purchased 2 NoxTech Units for Testing at
  - Mills Pump Station (Natural Gas)
  - San Jacinto Water Reclamation Facility (Digester Gas)
- **Critical Requirement:** Biogas Applications must be able to operate on natural gas as a back-up fuel

** ppmvd = parts per million by volume (dry)*

Site Differences

- **Woodville – Low BTU Landfill Gas**
  - Low Flame Speed (Combustion Inhibitors)
  - Lower Reactor Temperatures
  - Higher Exhaust Gas Flow Rates (Better Mixing)
  - Lean Burn Engines
  - Two Engines
    - 1 MW Generator (Diesel)
    - 600 kW Generator (Biogas)
- **Mills Pump Station – Natural Gas**
  - High Flame Speed (No Combustion Inhibitors)
  - High Reactor Temperatures
  - Low Exhaust Gas Flow Rate (Less Mixing)
  - Rich Burn Engines
  - Three Engines
    - 550 HP Direct Drive
    - 330 HP Direct Drive
    - 250 HP Direct Drive

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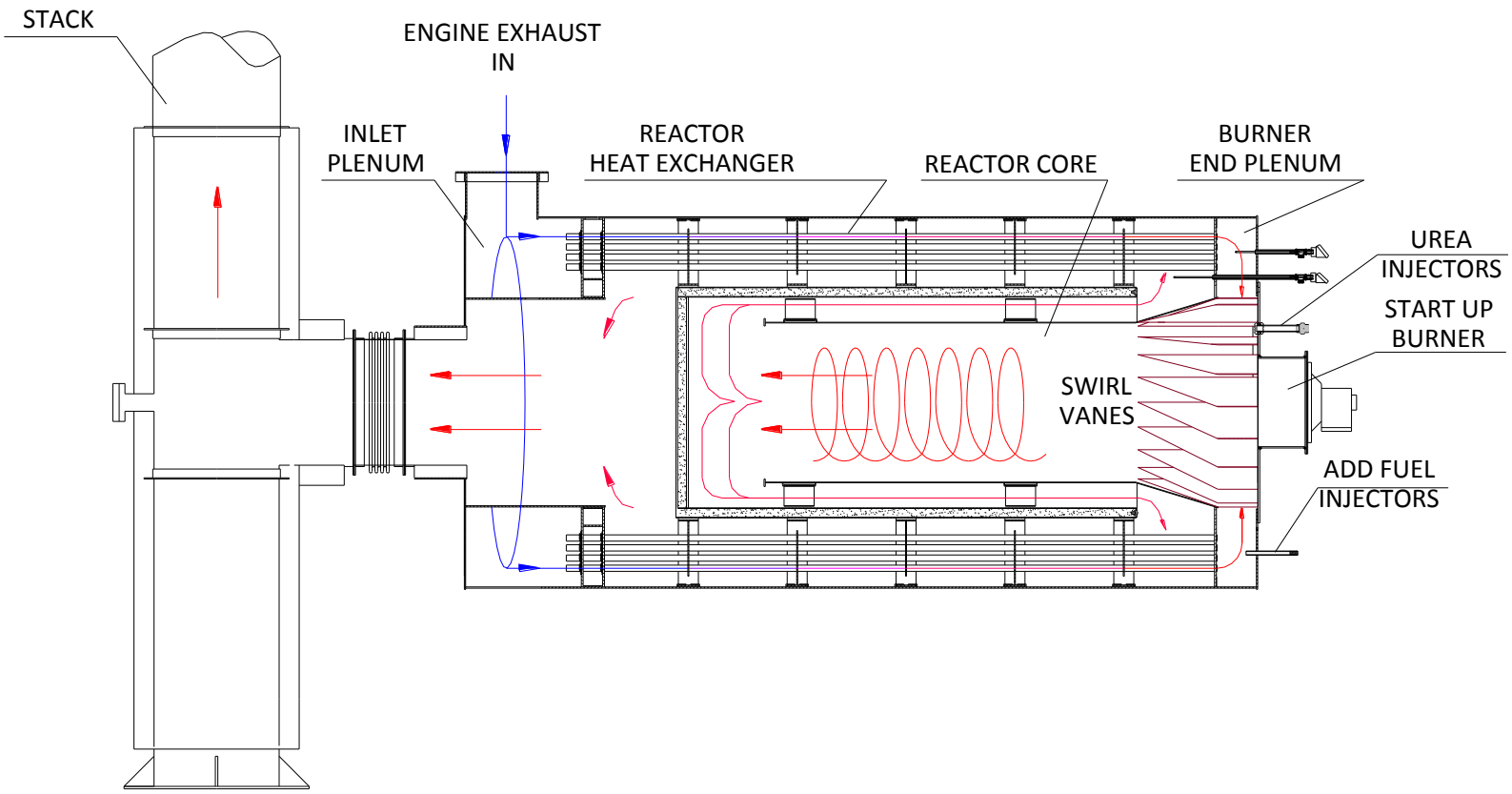
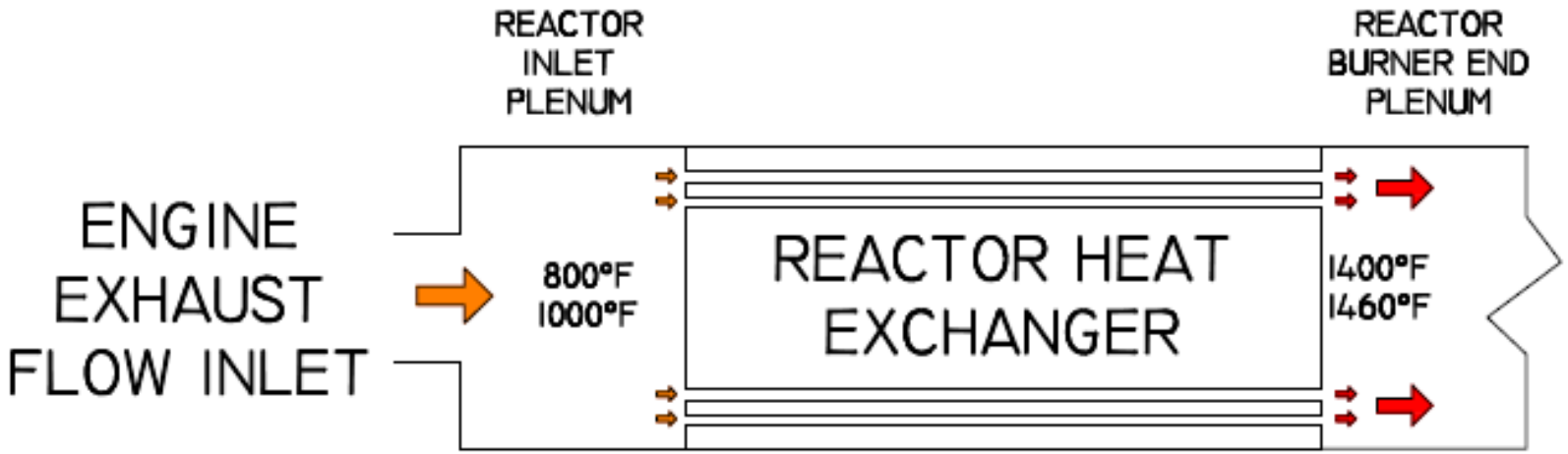
Reactor Cross-Section



Noxtech Process Description

STAGE 1: Exhaust Preheating

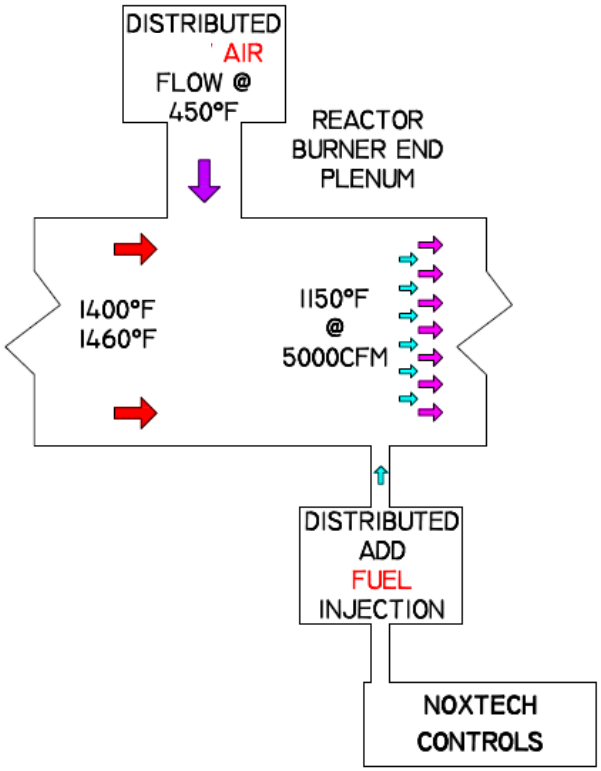
UNTREATED ENGINE EXHAUST FLOWS INTO THE REACTOR
AND IS HEATED IN THE REACTOR HEAT EXCHANGER



Noxtech Process Description

STAGE 2: Burner End Plenum

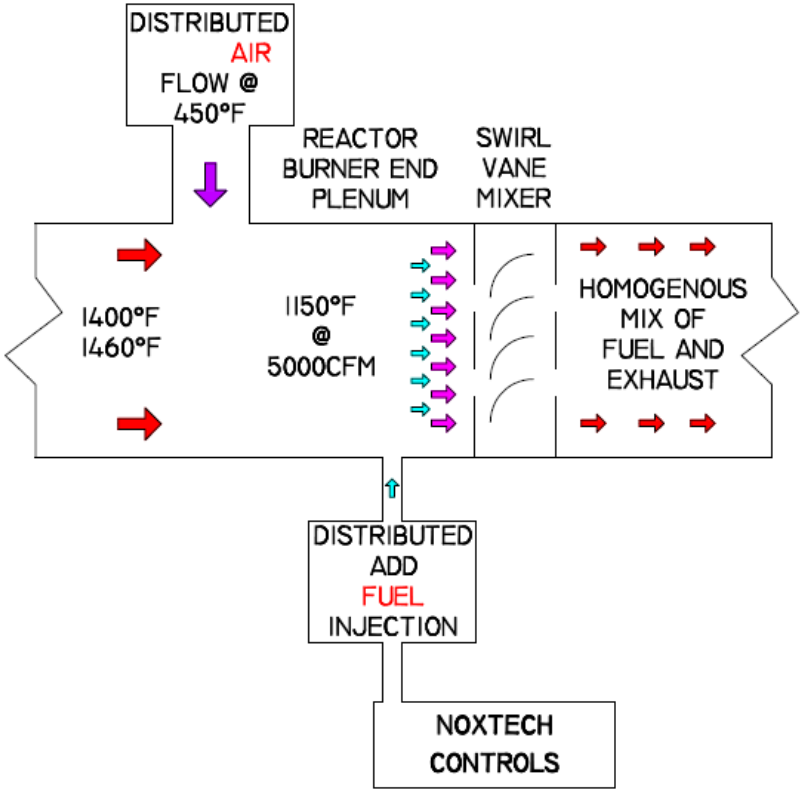
AIR AND **FUEL** ARE ADDED TO ADJUST THE FLOW RATE, OXYGEN CONTENT AND TEMPERATURE OF THE GAS.



Noxtech Process Description

STAGE 3: Mixing

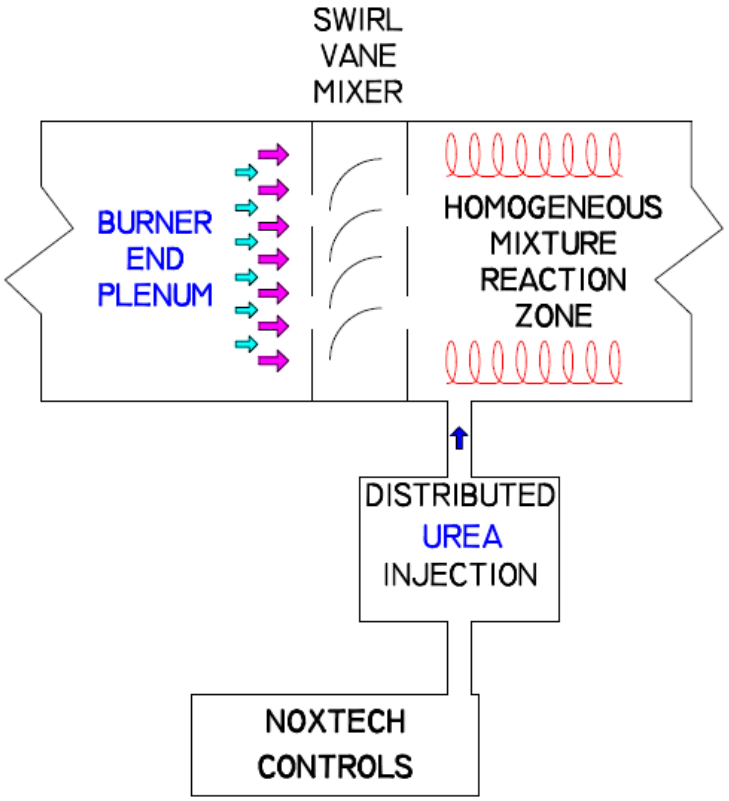
THE GAS FLOWS THROUGH THE SWIRL VANES TO PRODUCE A HOMOGENEOUS MIXTURE.



Noxtech Process Description

STAGE 4 – Urea Injection

UREA IS INTRODUCED AND THE HOMOGENEOUS MIXTURE PASSES INTO THE REACTOR CORE



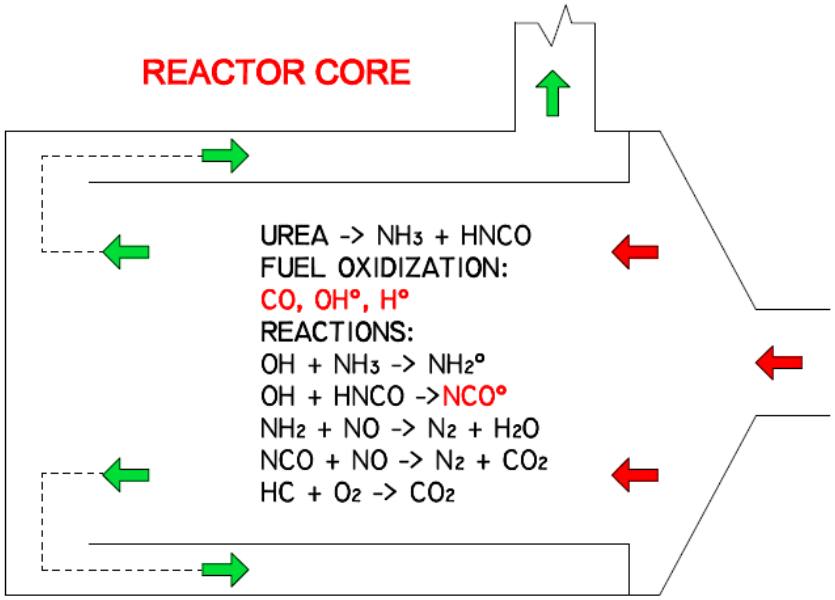
Noxtech Process Description

STAGE 5 – Emissions Removal

- THE FUEL OXIDIZES PROVIDING HEAT AND FORMING THE REACTIVE (Free Radicals) CHEMICAL SPECIES:

  CO, OH°, H°, NCO°,

- UREA IS DECOMPOSED AND ACTIVATED
- NOx, CO, VOC Removed



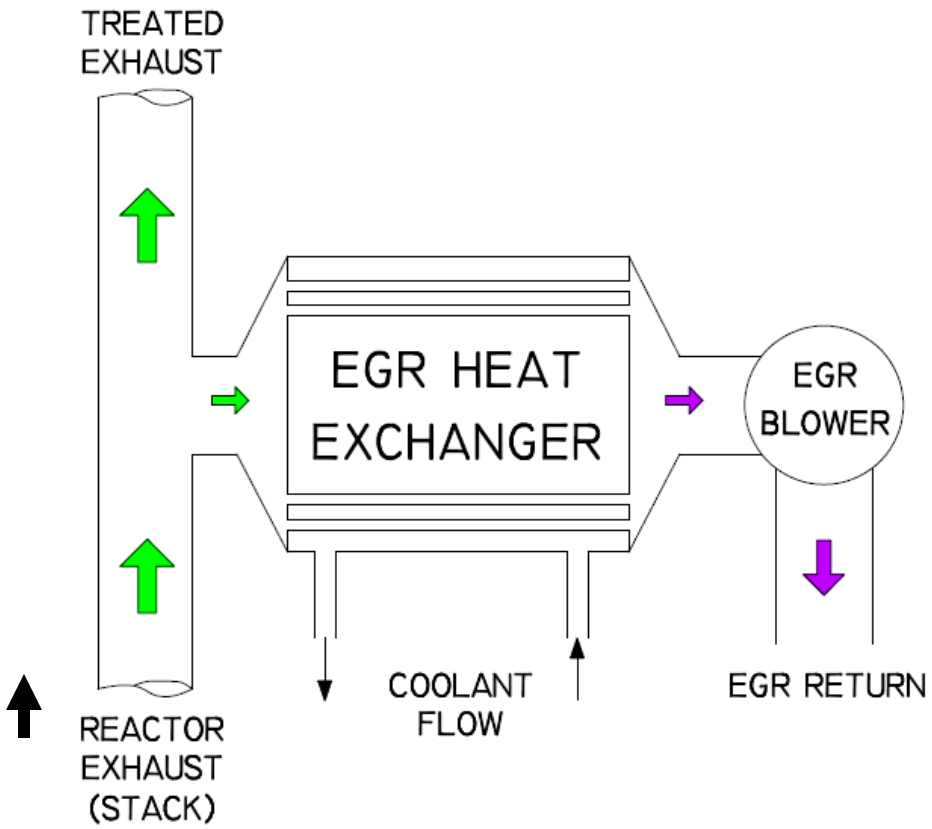
NoxTech Process Modification

- Provide Exhaust Gas Recirculation (EGR)

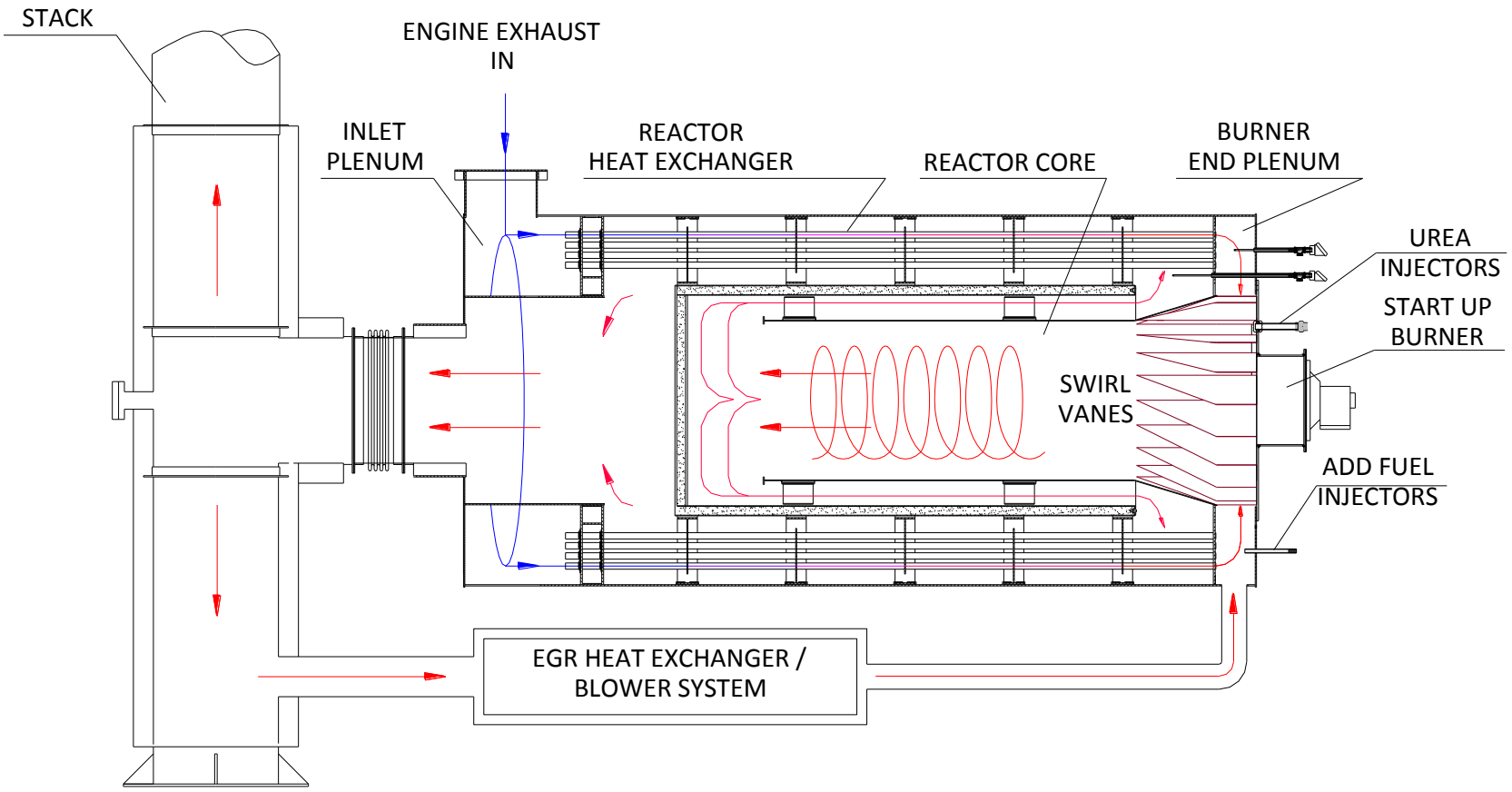
  Treated exhaust gas cooled and recirculated to reactor plenum to:

  - Reduce Flame Speed
  - Decrease Burner End Plenum Temperature
  - Increase Formation of Free Radicals in the Reaction Zone
  - Decrease Retention Time in the Burner End Plenum
  - Increase Flow into Reactor Section to Increase Mixing

EGR Modification



Reactor Cross-Section With EGR



Next Steps

- Obtain Variance to Continue Testing
- Install EGR Device
- Resume Start-Up Testing

Questions?